Arizona Department of Health Services
Chemical/Hazardous Materials Emergency Response Plan

Division of Public Health Services
Bureau of Emergency Preparedness and Response

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Version 1.0

Introduction:

This response plan provides an overview of the role of the Arizona Department of Health Services (ADHS) in a chemical/hazardous materials incident. There are many means by which a chemical or hazardous substance could be introduced to the public.

- Facility
- Highway
- Pipeline
- Railroad
- Weapons of Mass Destruction (WMD)

Goal of Plan:

The goal of this plan is to:

Serve as a resource for public health first responders, healthcare practitioners and the public regarding the assessment of health hazards and other public health concerns as a part of a chemical response.

Authorities:

The following citations represent portions of the statutory authorities available to the Department for a chemical/hazardous materials response. For a more complete listing, please refer to the ADHS Emergency Response Plan Authorities section and the Arizona Revised Statues (ARS) available at: http://www.azleg.state.az.us/arizonarevisedstatutes.asp

ARS§ 36-104 1.b.
Powers and Duties (of the Department)

1. Administer the following duties

(b) Public health support services, which shall include, but not be limited to:

(i) Consumer health protection programs, to include, but not be limited to, the functions of community water supplies, general sanitation, vector control and food and drugs.

(ii) Epidemiology and disease control programs, to include, but not be limited to, the functions of chronic disease, accident and injury control, communicable diseases, tuberculosis, venereal disease and others.

(iii) Laboratory services programs.

(iv) Health education and training programs.

(v) Disposition of human bodies programs.

ARS§ 36-132
Department of health services; functions; contracts

A. The department shall, in addition to other powers and duties vested in it by law:

1. Protect the health of the people of the state.

2. Promote the development, maintenance, efficiency and effectiveness of local health departments or districts of sufficient population and area that they can be sustained with reasonable economy and efficient administration, provide technical consultation and assistance to local health departments or districts, provide financial assistance to local health departments or districts and services that meet minimum standards of personnel and performance and in accordance with a plan and budget submitted by the local health department or districts to the department for approval, and recommend the qualifications of all personnel.

3. Collect, preserve, tabulate and interpret all information required by law in reference to births, deaths and all vital facts, and obtain, collect and preserve information relating to the health of the people of the state and the prevention of diseases as may be useful in the discharge of functions of the department not in conflict with the provisions of chapter 3 of this title, and sections 36-693, 36-694 and 39-122.

4. Operate such sanitariums, hospitals or other facilities assigned to the department by law or by the governor.

5. Conduct a statewide program of health education relevant to the powers and duties of the department, prepare educational materials and disseminate information as to conditions affecting health, including basic information for the promotion of good health on the part of individuals and communities, and prepare and disseminate technical information concerning public health to the health professions, local health officials and hospitals.

11. Establish and maintain adequate serological, bacteriological, parasitological, entomological and chemical laboratories with qualified assistants and facilities necessary for routine examinations and analyses and for investigations and research in matters affecting public health.

12. Supervise, inspect and enforce the rules concerning the operation of public bathing places and public and semipublic swimming pools adopted pursuant to section 36-136, subsection H, paragraph 10.

13. Take all actions necessary or appropriate to ensure that bottled water sold to the public and water used to process, store, handle, serve and transport food and drink are free from filth, disease-causing substances and organisms and unwholesome, poisonous, deleterious or other foreign substances. All state agencies and local health agencies involved with water quality shall provide to the department any assistance requested by the director to ensure that this paragraph is effectuated.

14. Enforce the state food, caustic alkali and acid laws in accordance with chapter 2, article 2 of this title, chapter 8, article 1 of this title and chapter 9, article 4 of this title, and collaborate in the enforcement of the federal food, drug and cosmetic act of 1938 (52 Stat. 1040; 21 United States Code sections 1 through 905).

17. License and regulate health care institutions according to chapter 4 of this title.

18. Issue or direct the issuance of licenses and permits required by law.

21. License and regulate the health and safety of group homes for the developmentally disabled.

ARS§ 36-136
Powers and duties of director, compensation of personnel

A. The director shall:

4. Administer and enforce the laws relating to health and sanitation and the rules of the department.

5. Provide for the examination of any premises if the director has reasonable cause to believe that on the premises there exists a violation of any health law or rule of the state.

6. Exercise general supervision over all matters relating to sanitation and health throughout the state.

7. Prepare sanitary and public health rules.

D. The director may delegate to a local health department, county environmental department or public health services district any functions, powers or duties that the director believes can be competently, efficiently and properly performed by the local health department, county environmental department or public health services district.

H.2. Define and prescribe reasonably necessary measures, in addition to those prescribed by law, regarding the preparation, embalming, cremation, interment, disinterment and transportation of dead human bodies and the conduct of funerals, relating to and restricted to communicable diseases and regarding the removal, transportation, cremation, interment or disinterment of any dead human body.

H.4. Except as relating to the beneficial use of wildlife meat by public institutions and charitable organizations pursuant to title 17, prescribe reasonably necessary measures to assure that all food or drink, including meat and meat products and milk and milk products sold at the retail level, provided for human consumption is free from unwholesome, poisonous or other foreign substances and filth, insects or disease-causing organisms. The rules shall prescribe reasonably necessary measures governing the production, processing, labeling, storing, handling, serving and transportation of such food and drink.

H.5. Prescribe reasonably necessary measures to assure that all meat and meat products for human consumption handled at the retail level are delivered in a manner and from sources approved by the Arizona department of agriculture and are free from unwholesome, poisonous or other foreign substances and filth, insects or disease-causing organisms. The rules shall prescribe standards for sanitary facilities to be used in identity, storage, handling and sale of all meat and meat products sold at the retail level.

H.6. Prescribe reasonably necessary measures regarding production, processing, labeling, handling, serving and transportation of bottled water to assure that all bottled drinking water distributed for human consumption is free from unwholesome, poisonous, deleterious or other foreign substances and filth or disease-causing organisms.

H.7. Define and prescribe reasonably necessary measures governing ice production, handling, storing and distribution to assure that all ice sold or distributed for human consumption or for the

preservation or storage of food for human consumption is free from unwholesome, poisonous, deleterious or other foreign substances and filth or disease-causing organisms.

H.8. Define and prescribe reasonably necessary measures concerning sewage and excreta disposal, garbage and trash collection, storage and disposal, and water supply for recreational and summer camps, campgrounds, motels, tourist courts, trailer coach parks and hotels.

H.9. Define and prescribe reasonably necessary measures concerning the sewage and excreta disposal, garbage and trash collection, storage and disposal, water supply and food preparation of all public schools. The rules shall prescribe minimum standards for sanitary conditions that shall be maintained in any public school and shall provide for inspection of such premises and facilities and for abatement as public nuisances of any premises that do not comply with the minimum standards.

H.10. Prescribe reasonably necessary measures to prevent pollution of water used in public or semipublic swimming pools and bathing places and to prevent deleterious health conditions at such places. The rules shall prescribe minimum standards for sanitary conditions that shall be maintained at any public or semipublic swimming pool or bathing place and shall provide for inspection of such premises and for abatement as public nuisances of any premises and facilities that do not comply with the minimum standards. The rules shall be developed in cooperation with the director of the department of environmental quality and shall be consistent with the rules adopted by the director of the department of environmental quality pursuant to section 49-104, subsection B, paragraph 12.

I. The rules adopted under the authority conferred by this section shall be observed throughout the state and shall be enforced by each local board of health or public health services district, but this section does not limit the right of any local board of health or county board of supervisors to adopt ordinances and rules as authorized by law within its jurisdiction, provided that the ordinances and rules do not conflict with state law and are equal to or more restrictive than the rules of the director.

ARS§36-601
Public nuisances dangerous to public health

A. The following conditions are specifically declared public nuisances dangerous to the public health:
2. Any spoiled or contaminated food or drink intended for human consumption.

9. The pollution or contamination of any domestic waters.

18. Water, other than that used by irrigation, industrial or similar systems for nonpotable purposes, sold to the public, distributed to the public or used in production, processing, storing, handling, servicing or transportation of food and drink which is unwholesome, poisonous or contains deleterious or foreign substances or filth or disease causing substances or organisms.

ARS§36-904
Food Adulteration

A. A food is adulterated if one or more of the following conditions exist:

1. It bears or contains any poisonous or deleterious substance which may render it injurious to health, but if the substance is not an added substance such food shall not be considered adulterated under this paragraph if the quantity of such substance in such food does not ordinarily render it injurious to health.

4. It consists in whole or in part of a diseased, contaminated, filthy, putrid or decomposed substance, or it is otherwise unfit for food.

5. It has been produced, prepared, packed or held under insanitary conditions whereby it may have become contaminated with filth, or whereby it may have been rendered diseased, unwholesome or injurious to health.

7. Its container is composed in whole or in part of any poisonous or deleterious substance which may render the contents injurious to health.

ARS§36-910
Seizure

A. When the director finds or has probable cause to believe that any food is adulterated or misbranded within the meaning of this article as to be dangerous or fraudulent, he shall affix to such food or its container a tag or other appropriate marking, giving notice that such food is, or is suspected of being, adulterated or misbranded and has been detained or embargoed, and warning all persons not to remove or dispose of such food by sale or otherwise until permission for removal or disposal is given by the director or the court. It is unlawful for any person to remove or dispose of such detained or embargoed food by sale or otherwise without such permission.

D. When the director finds in any room, building, vehicle of transportation or other structure any meat, sea food, poultry, vegetable, fruit or other perishable foods which are unsound or contain any filthy, decomposed or putrid substances, or which may be poisonous or presents an imminent endangerment to health, the director shall forthwith seize them and, unless within five days of such seizure the claimant serves a written protest to such action upon the director, destroy them. If such a written protest is timely served on the director, he may petition the court as in subsection B of this section for an order condemning the food. An action brought under this subsection shall be given a calendar preference by the court.

ARS§41-1081
Standards for delegation

(This statute describes the criteria for developing delegation agreements to the county governments and making them valid)

Roles and Responsibilities:

The Arizona Department of Health Services (ADHS) will:

- Support the local health departments and broker resources as much as possible including hospital space and emergency medical services.
- Provide chemical laboratory testing services
- Provide a Department liaison to the State Emergency Operations Center (SEOC) if it is opened
- Provide a Public Information Officer to craft (in conjunction with the local health departments) to craft various health messages for the State Emergency Operations Center's (SEOC) Joint Information Center (JIC)
- Coordinate with the Centers for Disease Control and Prevention
- Utilize pre-positioned statewide chemical antidote caches
- Order the Strategic National Stockpile if needed (See ADHS SNS Plan)
- Work with the CDC, Agency for Toxic Substances and Disease Registry (ATSDR) and local health departments to put together a registry*

***Registry:**

A registry is comprised of the contact information of persons potentially exposed to a hazardous substance will be assembled with the collaboration of CDC, ATSDR, ADHS and the local health department(s). The purpose of the registry is for subsequent exposure assessments; possibly providing the registrants educational material regarding their exposures, possible medical follow-up should that become necessary and for addressing possible long-term health effects. The registry is comprised of a one-page survey instrument. CDC/ASTDR will provide the survey instrument and the personnel to assist ADHS and the local health department in this endeavor. (See Appendix A for an example of the registry and Appendix B for a more detailed description of the ATSDR and what they can provide during an emergency)

The Operations/Environmental Health Group will:

- Provide public health information related to public health issues such as sheltering-in-place, potable water supply and food safety.**
- Give guidance and recommendations on environmental and public health issues to the State Prison kitchens as well as Assisted Living and Group Homes.
- Inspect various shelters for sanitation and cleanliness
- Support (if needed) the local health departments and the Arizona Department of Agriculture in utilizing the embargo authority, conducting inspections and gathering samples**
- Conduct public health risk assessments to provide acceptable levels of toxic substances in water, air and soil and to anticipate the type and magnitude of adverse human health effects associated with exposure to toxic substances. (See Resources section)
- Provide support to the Arizona Department of Environmental Quality (ADEQ) and the local health department(s) to advise on safe drinking water and community water systems

Responsibility for general food safety is delegated through delegation agreements to the county public health departments. In addition to chemical contamination there may be more traditional

food safety circumstances to contend with such as proper refrigeration of foods in the event of a power outage. (See the ADHS Power Outage Plan)

**** Food Safety:**

The responsibility of the county health departments for safe foodstuffs includes produce warehouses, food processing, outdoor settings, (special events) school cafeterias, restaurants and retail settings (grocery stores, convenience stores). The responsibility for the safety of eggs, dairy, raw meats, grains and fresh fruits and vegetables (in the field or on the farm) is overseen by the Arizona Department of Agriculture.

ADHS State Public Health Laboratory:

The Chemistry section of the ADHS State Public Health Laboratory is comprised of the following programs: Inorganics, Organics, Hazardous Materials, Chemical Emergency Response (CT), Food Safety & Surveillance and Biomonitoring. Because of these programs, the laboratory is proficient with a wide range of analytical instrumentation that enables the analysis of most matrices for many analytes of interest. Water, soil, sludge, solid waste, food, and clinical (blood & urine) samples are analyzed routinely using EPA, FDA, or CDC approved methods.

With regards to chemistry preparedness activities, the ADHS State Public Health Laboratory is a Level 2 facility as defined in the CDC's Laboratory Response Network (LRN). This allows the CT section to analyze cyanide in blood, trace metals in urine, arsenic and selenium in urine, plus very soon, both heavy metals in blood and nerve agent metabolites in urine. Membership in the EPA's eLRN (Environmental Laboratory Response Network) is part of Chemistry's credentials along with the responsibility to analyze emergency environmental samples. Chemistry is also a member of the FDA's FERN network and a recipient of an FDA co-operative agreement that requires surveillance testing of food products for toxic chemical agents.

The Chemistry section has the duty to provide identification of unknown substances deemed important by law enforcement, county health departments or other government entities within Arizona. The Chemistry section of the ADHS Public Health Laboratory can analyze environmental and biological matrices for many compounds. Exceptions include radiological samples, explosives testing, and some controlled substances.

Personnel Safety

The Bureau of Emergency Preparedness and Response has an industrial hygienist who can be used as a resource to recommend personal protective gear and other safety precautions in the event of a chemical incident.

Concept of Operations:

Under this plan, the Department will utilize its incident command system called the Public Health Incident Command System (PHIMS) to manage the incident. (See Appendix B) The

ADHS PHIMS response system is divided into four functional areas: Operations, Planning, Logistics and Finance.

The Operations Section functions specific to this incident will include the following:

- Give technical advice on health hazards during a response, safe food, water supply and use and other public health issues
- Provide chemical analyses of unknown materials
- Write environmental and public health messages for the public, healthcare practitioners and first responders
- Maintain and update as necessary the ADHS 24-hour recorded information line
- Track epidemiological data
- Support of local health departments for resources and staff time
- Environmental Health functions described above

The Planning Section will cover the following activities:

- Maintenance of the PHIMS Chart
- Generation of the Incident Action Plan
- Documentation of the Incident Log on SIREN as necessary
- Collection of information and compilation of Situation Reports
- Creation of GIS maps as needed
- Preparation of reports to the Governor

The Logistics Section will handle the following:

- Set up (as needed) the Health Emergency Operations Center (HEOC)
- Send blast faxes and other alerts and notifications through the Health Alert Network (HAN) and the EMSystem
- Use scripts and written materials from the Operations Communications Group, maintain and update as necessary the ADHS 24-hour recorded information line (in both English and Spanish) and ADHS website
- Track Department volunteers
- Obtain the number of webpage hits to specific ADHS information pages
- Obtain the number of callers to the 24-hour recorded information Line

The Finance Section will perform the following:

- Track hours spent on Chemical/Hazardous Substances response activities
- Give assistance with budgeting for the response
- Obtain contracts and procure needed items.

Statewide Coordination:

The Department is listed as a support agency in Emergency Support Function (ESF 10) Hazardous Materials Annex of the State Emergency Response and Recovery Plan (SERRP.) A copy of the current SERRP is located on SIREN at the following path:
Public Health Preparedness Portal/State Health/Response Plans/ADEM Plans/SERRP December 2003 Revision 1.0

Federal Coordination:

There are several possible avenues that the federal government can take in the event of an actual or potential discharge of oil or hazardous materials. The National Oil and Hazardous Substances Pollution Contingency Plan (NCP) (found at 40 CFR part 300) http://www.epa.gov/oilspill/pdfs/40cfr300.pdf alone may be activated. The hazardous materials addressed under the NCP include certain substances considered weapons of mass destruction. However, if the incident is being addressed through the NCP and is considered to be an Incident of National Significance, the response activation is described in the Oil and Hazardous Materials Annex.of the National Response Framework (NRF). If the incident is an Incident of National Significance but is not being handled through the NCP, then the procedures described in Emergency Support Function #10 – Oil and Hazardous Materials Response apply.

APPENDICES:

A: RRR Survey Form
B. "What you can expect from ATSDR"
C. ATSDR Public Health Hazard Categories
D: PHIMS Chart
E: Chemical Agent Quick List
F: Resources
G: Personal Protective Equipment (PPE) Levels (Chart)
H: Civilian Personal Protective Equipment Levels (Description)
I: Toxicology Basics

APPENDIX C:
Agency for Toxic Substances and Disease Registry
Public Health Hazard Categories
http://www.atsdr.cdc.gov/COM/hazcat.html

Depending on the specific properties of the contaminant, the exposure situations, and the health status of individuals, a public health hazard may occur. Using data from public health assesments, sites are classified using one of the following public health hazard categories:

Category 1: Urgent Public Health Hazard

Sites that pose a serious risk to the publics health as the result of short-term exposures to hazardous substances.

Category 2: Public Health Hazard

Sites that pose a public health hazard as the result of long-term exposures to hazardous substances.

Category 3: Indeterminate Public Health Hazard

Sites for which no conclusions about public health hazard can be made because data are lacking.

Category 4: No Apparent Public Health Hazard

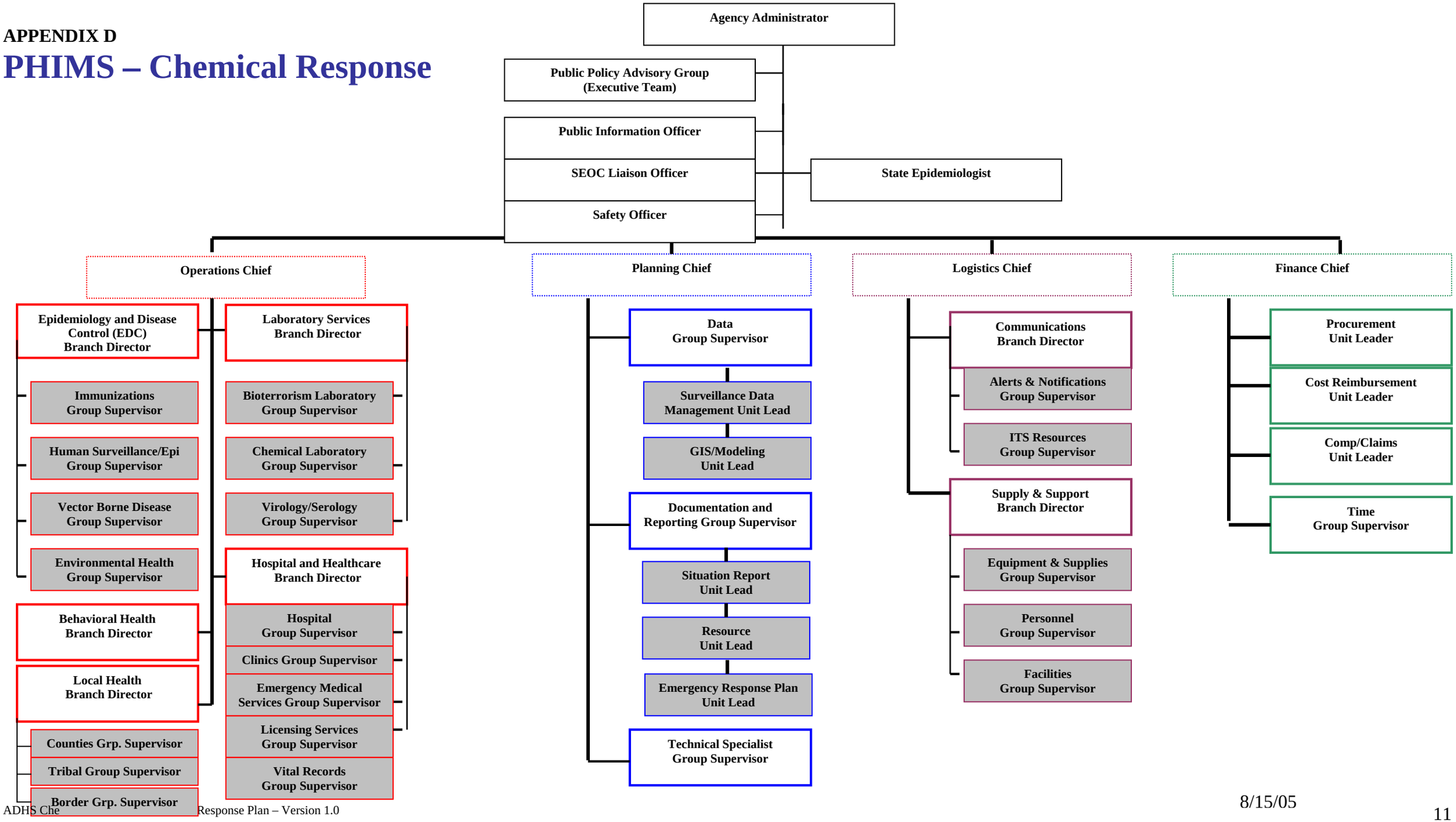
Sites where human exposure to contaminated media is occurring or has occurred in the past, but the exposure is below a level of health hazard.

Category 5: No Public Health Hazard

Sites for which data indicate no current or past exposure or no potential for exposure and therefore no health hazard.

APPENDIX D

PHIMS – Chemical Response



APPENDIX E
Chemical Agent Quick list:

- **nerve agents**,
  - tabun (ethyl N,N-dimethylphosphoramidocyanidate),
  - sarin (isopropyl methylphosphanofluoridate),
  - soman (pinacolyl methyl phosphonofluoridate),
  - GF (cyclohexylmethylphosphonofluoridate),
  - VX (o-ethyl-[S]-[2-diisopropylaminoethyl]-methylphosphonothiolate);
- **blood agents**,
  - hydrogen cyanide,
  - cyanogen chloride;
- **blister agents**,
  - lewisite (an aliphatic arsenic compound, 2-chlorovinyldichloroarsine),
  - nitrogen and sulfur mustards,
  - phosgene oxime;
- **heavy metals**,
  - arsenic,
  - lead,
  - mercury;
- **Volatile toxins**,
  - benzene,
  - chloroform,
  - trihalomethanes;
- **pulmonary agents**,
  - phosgene,
  - chlorine,
  - vinyl chloride;
- **incapacitating agents**,
  - BZ (3-quinuclidinyl benzilate);
- **pesticides**, persistent and nonpersistent;
- **dioxins**, **furans**, and polychlorinated biphenyls (PCBs);
- **explosive nitro compounds and oxidizers**,
  - ammonium nitrate combined with fuel oil;
- **flammable industrial gases and liquids**,
  - gasoline,
  - propane;
- **poison industrial gases, liquids, and solids**,
  - cyanides,
  - nitriles; and
- **corrosive industrial acids and bases**,
  - nitric acid,
  - sulfuric acid.

*Taken from Biological and Chemical Terrorism: Strategic Plan for Preparedness and Response-Recommendations of the CDC Strategic Planning Group. http://www.cdc.gov/mmwr/preview/mmwrhtml/rr4904a1.htm#top

APPENDIX F
Resources:

The Agency for Toxic Substances and Disease Registry (ATSDR) has a number of resources available on their website. These resources cover those hazardous materials that may be encountered at a hazardous waste site.

- Toxicological Profiles – An extensive information sheet on hazardous substances listed from A-Z. http://www.atsdr.cdc.gov/toxpro2.html

- Public Health Statements – A series of summaries of hazardous substances listed from A-Z. http://www.atsdr.cdc.gov/phshome.html

- TOX FAQs – Fact Sheets summarized from the Toxicological Profiles and Public Health Statements http://www.atsdr.cdc.gov/toxfaq.html

Centers for Disease Control and Prevention

- Chemical Agents from A-Z http://www.bt.cdc.gov/Agent/agentlistchem.asp

The **U.S. Environmental Protection Agency (EPA)**

- Alphabetical order a total of 364 extremely hazardous substances and provides profiles and first aid guidelines. http://yosemite.epa.gov/oswer/ceppoehs.nsf/Alphabetical_Results!OpenView&Start=1

- EPA list of Chemical Health and Safety Data Websites http://yosemite.epa.gov/oswer/ceppoweb.nsf/content/chemicalinfo.htm#national

National Institute for Occupational Safety and Health (NIOSH)

- Pocket Guide to Chemical Hazards http://www.cdc.gov/niosh/npg/default.html

- Emergency Response Resources, Chemical Agent Information http://www.cdc.gov/niosh/topics/emres/chemagent.html

Contact Phone Numbers:

- National Response Center: 800-424-8802
- Centers for Disease Control and Prevention: 888-232-3228
- U.S. Public Health Service: 800-USA-NDMS
- **CHEMTREC: 1-800-424-9300** http://www.chemtrec.com/Chemtrec/

CHEMTREC is a hotline for fire fighters, law enforcement, and other emergency responders to obtain critical information and assistance for emergency incidents involving chemicals and hazardous materials.

APPENDIX G	PERSONAL PROTECTIVE EQUIPMENT LEVELS			
LEVEL	**USED WHEN**	**RESPIRATORY PROTECTION**	**ADDITIONAL EQUPMENT**	**TRAINING REQUIRED**
A	The chemical substance has been identified and requires the highest level of protection for skin, eyes, and the respiratory system. Substance with a high degree of hazard to the skin are known or suspected to be present, and skin contact is possible. The substance is unknown, or the concentration is unknown or operations conducted in confined space, poorly ventilated areas until the absence of conditions requiring Level A protection is determined.	Pressure-demand, full-face respirator with self contained breathing apparatus (SCBA). only	Fully encapsulated chemical resistant sealed suit Chemical resistant Level A steel toed safety work boots Inner chemical resistant nitrile gloves	OSHA HAZWOPER or NFPA HAZMAT Site safety training
B	Level B - same level of respiratory protection as Level A, but provides less skin protection. The recommended minimum level of protection to initially enter a hazardous waste site or spill until hazards have been further identified. Level B is only used when the gases or vapors present are not suspected of containing high concentrations of chemicals that are harmful to the skin or capable of being absorbed through the skin. This level of protection should be used only when it is highly unlikely that the work being done will generate either high concentrations of vapors, gases, or particulates or splashes of material that will affect exposed skin.	Pressure-demand, full-face respirator with SCBA, or supplied air full-face respirator with escape SCBA.	Chemical resistant clothing (Overalls and long sleeved jacket) hooded, one or two piece chemical splash suit, disposable chemical-resistant one piece suit, or Level B fully encapsulated suit. Outer chemical resistant gloves with inner chemical resistant nitrile gloves. Chemical resistant steel toed safety work boots	OSHA HAZWOPER or NFPA HAZMAT Site safety training
C	The atmospheric contaminants, liquid splashes, or other direct contact will not adversely affect any exposed skin. The types of air contaminants have been identified, concentrations measured, and a canister or cartridge is available that can remove the contaminant. All criteria for the use of air-purifying respirators have been met.	Full-face or half-face air purifying cartridge or canister respirator	Chemical resistant clothing (Overalls and long sleeved jacket) hooded, one or two piece chemical splash suit, disposable chemical-resistant one piece suit. Outer chemical resistant gloves with inner chemical resistant nitrile gloves. Chemical resistant steel toed safety work boots	Respiratory protection training Site safety training
D	This level of protection affords only minimal protection. No respiratory protection is required with only minimal skin protection. The atmosphere contains no known hazard. The work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.	None required	Steel toed work boots, gloves, hardhat and other equipment as required.	Site safety training

APPENDIX H

CIVILIAN PERSONAL PROTECTION EQUIPMENT AND LEVELS

MAJOR TYPES OF RESPIRATORS

Self Contained Breathing Apparatus (SCBA)

SCBA provides the highest level of protection against airborne hazards when properly fitted to the user's face and properly used. National Institute for Occupational Safety and Health (NIOSH) respirator policies state that, under those conditions, SCBA reduces the user's exposure to the hazard by a factor of at least 10,000.

This reduction is true whether the hazard is from airborne particles, a chemical vapor, or a gas. SCBA respirators are used when hazards and airborne concentrations are either unknown or expected to be high. Respirators providing lower levels of protection are generally allowed once conditions are understood and exposures are determined to be at lower levels.

SCBA may be used in oxygen deficient atmospheres or under IDLH conditions.

Line Supplied Air or Air Line Respirators

Airline respirators protect against all airborne contaminants in concentrations that are below IDLH level. The airline consists of a half or full face respirator hooked by air line to a supply source. In many cases the same respirator can be used for either SCBA or with a different air attachment used for air line.

Air line when used in conjunction with an auxiliary tank on the belt for escape my be used in IDLH conditions. The advantage of the Line supplied respirators is reduction of weight from the SCBA tank and time is not limited due to amount of air in the tank.

Air Purifying Respirators (APR)

Air purifying respirator cartridges may be particulate, chemical absorption, and/or stacked meaning the cartridge filters out particles and has chemical protection. The particulate filter that is most appropriate for B-NICE particulate exposure is the HEPA or P100 filter which is magenta (pink) in color.

APR cartridges cannot be used for chemicals that:

- The chemical warning properties are below the PEL
- There are no warning properties (smell, taste, irritation, etc. for the chemical
- The chemical causes olfactory fatigue

APRs may not be used for IDLH, oxygen deficient atmospheres or with some chemicals. The cartridge is very specific as to the contaminant it will protect against. It is imperative that cartridge change out protocols be strictly adhered to.

NO CHEMICAL CARTRIDGE or APR IS APPROVED FOR NERVE AGENTS. PESTICIDE OR ORGANIC VAPOR CARTRIDGES SHALL NOT BE USED FOR WMD NERVE AGENTS.

Limitations of Air-Purifying Respirators For Gases And Vapors

APRs cannot be used in Immediate Danger to Life and Health (IDLH) atmospheres or in atmospheres containing less than 19.5% oxygen by volume. Gas mask (canister respirators) may be used for escape if the atmosphere is not oxygen-deficient. An IDLH Atmosphere is "An atmospheric concentration of any toxic, corrosive or asphyxiant substance that poses an immediate threat to life or would cause irreversible or delayed adverse health effects or would interfere with an individual's ability to escape from a dangerous atmosphere."

APR devices should not be allowed for either entry into or escape from hazardous environments when supporting evidence exists to demonstrate that unreasonably short service life would occur at the maximum use concentration.

APRs cannot be used for protection against gases and vapors with poor warning properties unless the respirator is approved with an effective End-Of-Service-Indicator. Warning properties are defined according to odor, taste, eye irritation, or respiratory irritation. Adequate warning properties that the gas or vapor of interest has a persistent odor or irritant effect at concentration at or below the OSHA PEL. Recognition of an odor depends upon a person's sensory ability to detect it. APRs cannot be used for gases or vapors that cause olfactory fatigue.

Powered Air Purifying Respirators (PAPR)

PAPRs carry the same limitations of other APRs. The added feature is a stream of fresh air that provides cooling and comfort.

Particulate Filter Respirators

MSHA/NIOSH particulate respirators and cartridges are certified according to seven basic categories.

- Dusts
- Fume
- Mists
- Dusts, Fume and Mists

- Radon Daughters
- Asbestos containing Dusts and Mists
- Single-Use Dust and Mist Respirators

N-95 Respirators.

Currently OSHA has only certified the N-95 for use with tuberculosis microdroplets.

CDC states that the N-95 will protect against other diseases in the microdroplet form such as small pox.

The N-95 respirator is a 95% HEPA filter.

They will Not protect against weapons grade biologicals such as *B. anthracis*.

FIT TESTING RESPIRATORS

OSHA Requires all respirators to be fit tested.

There are two basic methods of determining a proper respirator fit. One type is the qualitative fit test (QLFT) in which the wearer is placed in an atmosphere containing a challenge agent. This subjective test depends upon the employee being able to detect the challenge agent to determine leakage.

The other is quantitative fit testing (QNFT) where a fit test machine is used to determine whether or not the respirator leaks and numerically states the amount of leakage.

LEVELS OF PPE

The different levels of PPE used by NIOSH, OSHA, and EPA are listed below.

Level A

This level affords the highest level of respiratory, skin, and eye protection. Depending on the chemical Level A+ and Level A++ suites and/or protective equipment may be worn. Fully encapsulating chemical suits must be compatible with the substances involved.

Level B

Encapsulated

With SCBA

Line Supplied Air Respirator

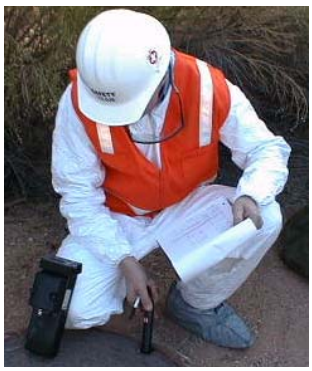
Level B affords the same level of respiratory protection as Level A, however provides less skin protection. It is the recommended minimum level of protection to initially enter a hazardous waste site or spill until hazards have been further identified.

Level C

Level C provides the same level of skin protection as Level B but a lower level of respiratory protection. Level C can only be used when Atmospheric concentrations do not exceed IDLH levels.

Air-purifying respirators may only be used when the chemical has a warning property or as Identified by ACGIH or OSHA. Air-purifying respirators (APR) may not be used for some chemicals and cannot be used in atmospheres that contain less than 19.5 percent oxygen.

Level D



This level of protection affords only minimal protection. No respiratory protection is required with only minimal skin protection.

The atmosphere contains no known hazard. The work functions preclude splashes, immersion, or the potential for unexpected inhalation of or contact with hazardous levels of any chemicals.

BIOLOGICAL HAZARD PPE REQUIREMENTS

CDC issued interim guidance for PPE for the biological threat in October 2001. It was based on current understanding of the potential threats and existing recommendations issued for biological aerosols. CDC made this judgment because:

Biological weapons may expose people to bacteria, viruses, or toxins as fine airborne particles. Biological agents are infectious through one or more of the following mechanisms of exposure, depending upon the particular type of agent: inhalation, with infection through respiratory mucosa or lung tissues; ingestion; contact with the mucous membranes of the eyes, or nasal tissues; or penetration of the skin through open cuts (even very small cuts and abrasions of which employees might be unaware).

- Organic airborne particles share the same physical characteristics in air or on surfaces as inorganic particles from hazardous dusts.

- Because biological weapons are particles, they will not penetrate the materials of properly assembled and fitted respirators or protective clothing.

- Some devices used for intentional biological terrorism may have the capacity to disseminate large quantities of biological materials in aerosols.

NIOSH/CDC Interim Recommendations for the selection and use of
protective clothing and respirators against biological agents

Responders should use a NIOSH-approved, pressure-demand SCBA in conjunction with a Level A protective suit in responding to a suspected biological incident where any of the following information is unknown or the event is uncontrolled:

- The type(s) of airborne agent(s);

- the dissemination method;

- if dissemination via an aerosol-generating device is still occurring or it has stopped but there is no information on the duration of dissemination, or what the exposure concentration might be.

Responders may use a Level B protective suit with an exposed or enclosed NIOSH- approved pressure-demand SCBA if the situation can be defined in which:

- the suspected biological aerosol is no longer being generated;

- other conditions may present a splash hazard.

Responders may use a full facepiece respirator with a P100 filter or powered air-purifying respirator (PAPR) with high efficiency particulate air (HEPA) filters when it can be determined that:

- an aerosol-generating device was not used to create high airborne concentration,

- dissemination was by a letter or package that can be easily bagged.

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APPENDIX I
INTRODUCTION TO HAZARDOUS MATERIALS AND TOXICOLOGY

In this module you will learn the basic hazards of chemicals. You will also learn some basic toxicology terms that will help you read and understand a material safety data sheet (MSDS).

1. A HAZARD HAS TWO COMPONENTS:

1.1. The first component is the inherent ability of a chemical to do harm. The toxicity of the chemical must be considered. A highly toxic chemical is much more hazardous than one that is not considered toxic.

1.2. The second component of a hazard is whether or not the chemical can contact a person. If the chemical is in a sealed container the hazard is minimal, however, if it is in an open container on a shelf, the hazard is increased.

2. RISK

The higher the probability of contact with a chemical increases the risk of exposure. At the same time the toxicity of the chemical must be considered. If the likelyhood of exposure is great, but, the chemical is non-toxic there is little risk involved. As the likelyhood of exposure and toxicity increases so does risk.

3. ROUTES OF ENTRY

There are only four routes of entry into the body: Inhalation, ingestion, dermal, and injection.

3.1. Inhalation

3.1.1. The most important route of entry is normally inhalation. The respiratory system is composed of two main areas. The *upper respiratory system* which consists of the nose, throat, trachea, and major bronchial tubes leading to the lungs. The *lower respiratory systems* consists of the lungs and the alveoli, where the actual transfer of gas takes place through delicate thin walls.

3.1.2. The lungs contain the largest surface area in the body. The lungs in an average adult contain approximately 750 ft^2 of surface area as compared to 20 ft^2 of the skin. In addition to tissue damage, chemicals can pass directly into the blood through the lung tissue. This is why people smoke marijuana rather than eat it.

3.2. Ingestion

The oral pathway is the primary way chemicals enter our body through food and water. This is why food and drink are not permitted in so many areas of the hospital. Ingestion

of chemicals can also occur due to poor hygiene. By not washing hands and face before going outside to smoke a cigarette.

3.3. Dermal

This is the second most common route of entry for chemicals. Many chemicals carry the designator "skin". This means the chemical will penetrate the skin, either by absorption or by breaking down the fatty oil barriers. The skin is a fairly good barrier to many chemicals. Usually dry chemicals are less reactive and do not enter the skin as quickly as liquid chemicals.

3.4. Injection

In industry injection is a very uncommon route of entry and is often omitted, however, in the health care industry it is common especially for transmitting diseases. Injection occurs when a sharp instrument penetrates the skin carrying the chemical or biological agent. Small amounts of beryllium entering the body can set up a sensitivity resulting in the fatal berylliosis disease. Cuts or openings in the skin are other ways chemicals can enter the body.

4. ACTION OF TOXIC SUBSTANCES

4.1. The toxic action of a substance can be arbitrarily divided into acute and chronic effects. In addition to acute and chronic toxicity, we can also distinguish acute and chronic exposures.

4.2. The terms come from the Greek acutus (sharpened) and chronikos (time).

4.3. Acute Effects

4.3.1. Acute effects and acute exposures generally involve short term high concentrations and immediate results of some kind (illness, irritation, death). Acute occupational exposures are usually related to an accident.

4.3.2. Acute exposures typically are sudden and severe and are characterized by rapid absorption of the offending materials. Such incidents generally involve a single exposure in which the chemical is rapidly absorbed and damages one or more organ system.

4.4. Chronic Effects

4.4.1. In contrast to acute effects, chronic effect or illness is characterized by symptoms or disease of long duration or frequent recurrence. Chronic effects often develop slowly. Chronic exposure means that some level of the chemical is continuously present in the tissues. Chronic poisoning can also be produced by exposure to a harmful material that produces irreversible damage so that the injury, rather than

the poison, accumulates or progresses (this is the mechanism behind asbestos and lung cancer).

4.4.2. The symptoms of chronic poisoning are usually different from those seen in acute poisoning by the same toxic agents and because the level of the contaminant is relatively low, the worker is often unaware of the exposures as they occur. Smoking is an example of a chronic exposure.

4.5. Combined Effects

Chemicals that affect the same organ system can be either additive in their effect, meaning 1 + 1 =2, or they can be synergistic, meaning that 1 + 1 = X.

4.5.1. Additive Effects

Additive effects mean that if there is a chemical exposure of several chemicals that all affect the same organ system that their combined effect is basically equal to the sum of the chemicals effects separately. For example if a employee is work with lacquer thinner containing toluene they are having a simple exposure to the central nervous system. If they go home and drink several drinks, the alcohol is affecting the same systems, therefore, there are two agents at work on the same systems

4.5.2. Synergistic effects

Synergism is known to occur with certain exposures. Probably the most widely recognized synergistic relationship is between smoking and exposure to asbestos. There is a very definite relationship between smoking and asbestos exposure. If you smoke, you are 10 times more likely to get lung cancer. If you are exposed to asbestos, you are five times more likely to contract lung cancer. Smoking and asbestos exposure form a synergistic relationship. This means the degree of effect is far above what is normally expected. In terms of mathematics 5 plus 10 or even 5 times 10 does not equal the increased risk. Instead, the synergistic effects increase exponentially so the actual increase of lung cancer risk if you smoke and are, or were, exposed to asbestos is now estimated from 95 to 240 times greater (depending upon which study you read).

4.6. Chemical Hazards

The hazards of a chemical have nothing to do with whether it is organic or man made:

4.6.1. A chemical, for example Vitamin C, whether organically grown or man made is identical. The body recognizes a chemical and reacts the same way where it came from is of no consequence.

4.6.2. Many people feel that man made chemicals are the most toxic. Nature has been making toxic chemicals before man was even in existence and has gotten very good at it. Toxic chemicals in nature are used to kill prey and for self defense. The most toxic substances in the world are made by mother nature.

4.6.3. Many people feel biodegradable chemicals are less toxic. All the term biodegradable means is that nature breaks down the chemical quickly. Some of the most toxic chemicals are biodegradable.

4.6.4. A chemicals hazard also has nothing to do with whether it is very complex molecule or a simple one. Hydrogen Cyanide (HCN) is a very simple molecule, however very toxic. It's how the chemical reacts with the body that is important.

5. HEALTH HAZARDS

5.1. Chemicals only present two kinds of hazards to people, health hazards and physical hazards. Some chemicals present more of a health hazard that others, some are mostly physically hazardous, while others are both.

5.2. *Health hazards* are manifested by what they do to the body in terms of making a person ill. Chemicals that cause cancer or that effect an organ fall into this category. An example is vinyl chloride, as it is known to cause bladder cancer.

5.3. In most cases health hazards from a chemical exposure take place some where else in the body other than the site of exposure. This is called the *target organ* effect. Going back to the organophosphate pesticides, if a person was exposed to the pesticide by having it splash on their body, there would be no effect to the skin, the site of exposure The effect would be on the target organ system, the nervous system. A chemical is considered a health hazard if it is:

6. TOXIC EFFECTS

Everything is a poison, there is nothing in this world that is not a poison, it is the dose that makes the poison and the poison makes the dose.

6.1. A toxic effect is any reversible or irreversible noxious effect on the body - any chemically induced tumor or any mutagenic or teratogenic effect or death - as a result of contact with a substance via the respiratory tract, skin, eye, mouth or any other route. Toxicity is divided into 5 categories, however each category comes with a dose.

6.1.1. *Highly Toxic* $LD_{50} < 50mg/kg$ Materials which on a very short exposure could cause death or major residual injury, even though prompt medical attention were given, including those chemicals that are too dangerous to be approached without specialized protective equipment.

6.1.2. *Moderately Toxic* LD_{50} up to 500 mg/kg Materials on which short exposure could cause serious temporary or residual injury, even though prompt medical attention were given, including those chemicals that requiring protection from all bodily contact.

6.1.3. *Slightly Toxic* LD_{50} 0.5 to 5 g/kg Materials that on intense or continued (not chronic) exposure, could cause temporary incapacitation or possible residual injury, including those requiring the use of protective equipment that has an independent air supply.

6.1.4. *Practically Nontoxic* LD_{50} 5 to 15 g/kg Materials which on exposure could cause irritation but only minor residual injury even if no treatment is given, including those which require use of an approved canister-type gas mask.

6.1.5. *Nontoxic* LD_{50} > 15 g/kg Materials which on exposure would offer no hazard and or no hazard exists.

6.2. LD_{50} and LC_{50}

6.2.1. LD_{50} means lethal dose and the 50 means that one dose was lethal to half the test population within a 14 day period. Lethal dose refers to an oral dose or an injection. Lethal doses are expressed in concentrations of milligrams per kilogram of subject or mg/kg.

6.2.2. LC_{50} means lethal air concentration and the 50 means that one dose as lethal to half the test population within a 14 day period. The lethal concentration is used for gasses and vapors. Lethal concentrations are expressed in milligrams per cubic meter or mg/m^3 or in parts per million (ppm).

6.2.3. The smaller the LD_{50} and LC_{50} the more toxic the substance. In some cases for extremely toxic chemicals the LD_{50} and LC_{50} concentrations are expressed in micrograms (µg).

6.2.4. Listed below are some toxic substances with an LD_{50}. These substances range from Highly Toxic to Practically Nontoxic.

TOXIC SUBSTANCE	LD_{50}	TOXICITY
Botulinum toxin	30pg/kg (oral mouse)	Highly Toxic
Sea Anemone Venom	56 µg/kg (injected rat)	Highly Toxic
Sea Snake Venom	155 µg/kg (injected mouse)	Highly Toxic
Potassium Cyanide	5 mg/kg (oral rat)	Highly Toxic
4,4-Methylenedianiline	8.4mg/kg (oral rabbit)	Highly Toxic
Hydrazine	96mg/kg (oral rabbit)	Moderately Toxic
Methylene Chloride	357mg/kg (oral dog)	Moderately Toxic

Sodium Chloride	3 g/kg (oral rat)	Slightly Toxic
Acetone	6 g/kg (oral rat)	Practically Nontoxic
Ethyl Alcohol	7g/kg (oral rat)	Practically Nontoxic

Note: Botulinum toxin 30 pg or picograms which can also expressed as 30 X 10^{-12} grams! The most toxic substance known to man. There are 945,000,000,000 lethal doses of botulinum in one ounce. More than enough to kill every person in the world many times over.... The division of metric weight is as follows:

1 ounce = 28.35 grams
1gram (g) =1000 milligrams (mg) or 1 mg = one thousandth of a gram
1mg = 1000 microgram (µg) or 1 µg = one millionth of a gram
1 µg = 1000 nanograms (ng) or 1ng = one billionth of a gram
1 ng = 1000 picograms (pg) or 1 pg = one trillionth of a gram

6.3. Irritants

An irritant is a chemical that causes an inflamation or aggravation of the tissue the material contacts. Contact of some materials with the face and upper respiratory system affects the eyes, the cells lining the nose and mouth. To a large part, water solubility directly influences the irritability of a chemical in the eyes, nose and lungs. A highly soluble chemical such as ammonia effects the upper respiratory system almost instantly, where a lesser soluble gases such as nitrogen oxides take more time to start to irritate tissue and the irritation will continue down deeper in the lungs.

6.3.1. Primary Irritants**.** These are chemicals that affect most people and in some cases affect everyone. These agents react on contact with the skin and cause damage. It may be a defatting agent such as xylene, which removes the oils from the skin, or an oxidizer, which may react with the skin.

6.3.2. Sensitizers. Some primary irritants also sensitize. Sensitizers or allergens can cause several different types of allergic reactions. These reactions, depending on the chemical, can be systemic or local in nature. During sensitization there is no effect, however, the next contact with the chemical will produce a greater reaction at a much lower concentration that would be expected thus indicating sensitization has occurred. Glutaraldehyde and formaldehyde are known Sensitizers.

6.4. Radioactive

Radiation is considered both a health and a physical hazard. Radiation can cause burns and depending upon the dosage can cause health concerns. One thing to remember is that often a person is exposed but not contaminated because the damage was done internally with no outside contamination. If you see the radio active sign on a chemical or on a container the safest thing is to stay away from it and keep others away until properly trained people take over. The effects of radiation can vary tremendously depending upon the dose and the type. The radiation symbol

may be in black and white, or it may be a light purple on orange or yellow. In any case the symbol means the contents are radioactive.

6.5. Asphyxiants

Asphyxiants interfere with oxygenation of the tissues and the affected individual may suffocate. This class is generally divided into two categories, simple asphyxiants and chemical asphyxiants.

6.5.1. Simple Asphyxiants. Simple asphyxiants are physiologically inert gasses that dilute or displace the oxygen below that required to maintain blood levels sufficient for normal tissue respiration. Common examples are carbon dioxide, ethane, nitrogen, helium, and methane.

6.5.2. Chemical Asphyxiants. Through their direct action, chemical asphyxiants prevent the uptake of oxygen by the blood, interfere with the transportation of oxygen from the lungs to the tissues, or prevent normal oxygenation of tissues even when the blood is well-oxygenated. Carbon monoxide interferes with the delivery of oxygen to the tissues. It combines with the hemoglobin to form carboxyhemoglobin. Carbon monoxide occupies oxygen's normal position on the hemoglobin molecule and therefore oxygenation does not take place. Hemoglobin combines with carbon monoxide more readily than oxygen at a rate of 300 to 1.

6.6. Can Cause Cancer Or Listed

A carcinogen can be defined as any agent than can produce or accelerate the development of malignant or potentially malignant tumors or malignant neoplastic proliferation of cells. Chemicals that cause cancer do so by mechanisms that are not completely defined. In most cases there is a *latency period*. Cancer causing exposures in most cases are not a one time exposure, rather, a low dose exposure over a period of time. Some of the major listing of carcinogenic chemicals appear in:

6.6.1. in the National Toxicology Program (NTP) Annual Report on Carcinogens,

6.6.2. in the International Agency for Research on Cancer (IARC) Monographs,

6.6.3. OSHA as a carcinogen

6.6.4. by NIOSH or other federal agencies as a carcinogen

6.6.5. by the American Conference of Governmental Industrial Hygienists (ACGIH) as a carcinogen.

7. PHYSICAL HAZARDS

7.1. Corrosive. Corrosive chemicals, in medical terms, are those that will burn you, or dissolve your skin, not that they will rust iron or cause other metals to corrode. These

chemicals include acids, bases, and many organic chemicals. The physical harm that they cause is usually localized tissue damage. If the spill or splash on a person is in the eyes it can be blinding. A large exposure can be fatal.

7.2. Combustible liquid. Any liquid having a flash point at or above 100^0F but below 200^0F. The Physical hazard of a combustible liquid is that it can ignite and burn a person.

7.3. Compressed gas . A gas or mixture of gases in a container having absolute pressure exceeding 40 pounds per square inch at 70^0F. The physical hazard of a compressed gas is that it under pressure and if that pressure is suddenly released it can cause frost bite. If the cylinder is dropped it can explode and a person can be injured by flying pieces of metal. The valve can also become a missile and the cylinder a torpedo.

7.4. Explosive. A chemical that causes a sudden, almost instantaneous release of pressure, gas and heat when subjected to sudden shock, pressure, or high temperatures. The physical hazards to explosives is that they can blow you up.

7.5. Flammable. To include solids, liquids (flash point below 100^0F) and gases. The hazards of flammable solids are exactly the same as combustible liquids.

7.6. Organic Peroxide. An organic compound having the bivalvent -O-O- (derivatives of hydrogen peroxide) other than hydrogen peroxide. These are the chemicals from hell. They react with everything even themselves and usually very quickly. Organic peroxides as a group of chemicals are to be considered explosive, toxic, water reactive, pyrophoric, unstable, shock sensitive and subject to rapid polymerization.

7.7. Water Reactive. A chemical that will react with water to release a gas that is either flammable or presents a health hazard. Most standard practices of patient decontamination require copious amounts of water, however if a water reactive chemical such as sodium is involved water cannot be used to decontaminate the person because the sodium will react with the water and start burning.

7.8. Pyrophoric. A chemical that will ignite spontaneously in air at a temperature of 130^0F or below. Some forms of phosphorus must be kept in water because if the chemical dries out it will spontaneously ignite. It has been used in arson so the person starting the fire can be far away when the fire starts, however, it also leaves a tell tail white residue.

7.9. Unstable (reactive). A chemical which in the pure state, or as produced or transported, will vigorously become self-reactive under conditions of shocks, pressure or temperature. Many of these chemicals are polymers and organic peroxides. Some chemicals such as ethyl ether (commonly called ether) will break down to an unstable state. A can of ether must always be dated and disposed of after one year because the chemical breaks down to a contact explosive and the friction of opening the cap can cause an explosion.

7.10. Materials Are Also Considered Hazardous If They Are Listed As Such By:

7.10.1 Environmental Protection Agency (EPA) under 40 CFR, OSHA, 29 CFR 1910, Subpart Z, or, the Department of Transportation 49 CFR parts 171-179.

7.10.2 Maritime Dangerous Goods Code of the Inter-Government Maritime Consultative Organization (IMCO) or Dangerous Goods Regulations of the International Air Transport Association (IATA).

7.10.3 EPA's Guide to Infectious Waste Management and is medical infectious waste which may contain such organisms as the hepatitis B virus (HBV), human immunodeficiency virus (HIV) or other human disease causing agents or is a cytotoxic, chemotherapeutic or antineoplastic chemical or waste.

7.10.4 Any other Governmental Agency Listing.

8. DOSE RESPONSE

8.1. Remember that a dose (as in LD_{50} and LC_{50}) is either an injection, oral, dermal, or an inhalation administration of a chemical. Therefore, you have a dose (a given amount) of a chemical and the response to that given dose. The threshold concept simply states that in small amounts even the most toxic chemicals are not harmful; there is a threshold effect or a no-effect level.

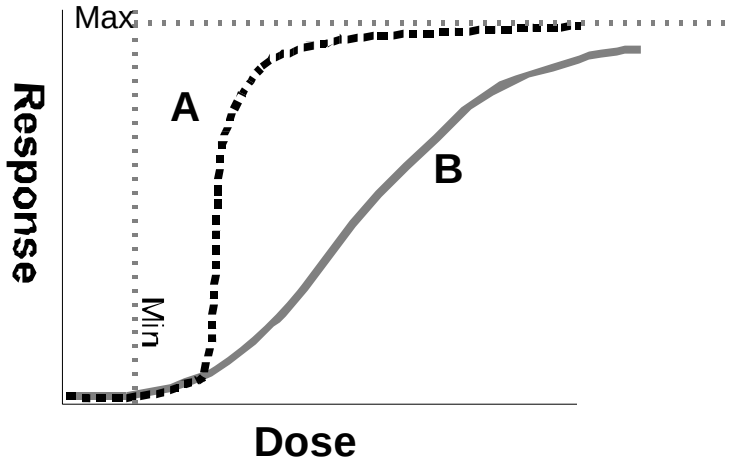

Figure 1. Dose response curve of two different chemicals.

8.2. The threshold concept simply states that in small amounts even the most toxic chemicals are not harmful; there is a threshold effect or a no-effect level. The toxin can damage a few cells, however, the overall effect on the body shows no measurable effect. As the dose increases there is a point where the first measurable effect is noted. This is shown as the minimal effect. As the dose increases the effect increases. Chemical A is much more toxic than chemical B because of the steepness of the dose response curve. In other words, it takes very little of Chemical A to go from the minimum effect to the maximum

effect. The increase on effect versus dose is much more gradual in chemical B. Chemical B is much safer to work with.

8.3. You probably have noticed that there is some overlap between hazards of chemicals. Many chemicals are both health hazards and physical hazards. An acid can be an irritant and the vapor can cause eye and respiratory irritation, or low concentrations can cause skin irritation. Higher concentrations can be a physical hazard because they can cause severe burns.

8.4. Some chemicals are both hazards simultaneously. Hydrogen fluoride, also called hydrofluoric acid, is both a health hazard and a physical hazard. The acid will burn you but it will also penetrate the skin and the fluoride ion has a great affinity (attraction) for the calcium in the blood. In this case the health hazard is much greater than the physical hazard. A person exposed to hydrofluoric acid can go into metabolic shock quite rapidly with our proper medical attention.

9. CHEMICALS AND INDOOR AIR QUALITY

9.1. Exposure Limits

9.1.1. Exposure limits are the maximum amount of exposure that a person may have. In most cases these limits are expressed as *Time Weighted Averages* (TWA). A TWA is the maximum exposure that a person may have over an 8 hour day, for 40 hours a week.

9.1.2. The Occupational Safety and Health Administration (OSHA) has set Permissible Exposure Limits (PEL) that are law. These exposure limits are based on the TWA principal.

9.1.3. The American Council of Governmental Industrial Hygienists (ACGIH) has set guidelines called Threshold Limit Values (TLV) and the National Institute of Occupational Safety and Health (NIOSH) has set Recommended Exposure Limits (REL). In many cases these are stricter than the OSHA PEL, however, the PEL is law. A problem is that if is a chemical is found to be more hazardous than when the initial PEL was developed OSHA must either promulgate another standard or change an existing standard. This may take years. This is why you will see differences in the PEL, TLV, and REL for the same chemical. One should always choose the lowest value to determine exposure rather than relying on what is law (the PEL) when it comes to employee safety.

9.1.4. Exposure limits are normally expressed as parts per million (ppm) or as milligram per meter cubed (mg/m^3).

9.1.5. Exposure Limits and an Indoor Air Quality Problem

9.1.5.1. Odor thresholds. The odor threshold is the limit at which most people can smell a chemical. This may or may not be at a safe level. For example:

9.1.5.1.1. *Low Odor Thresholds:* Xylene has a PEL and TLV of 100ppm. The odor threshold is around 0.05 ppm. This means that you will smell xylene long before it becomes a health hazard. People will complain about the smell of xylene long before it becomes a health hazard. In fact people will start complaining about a xylene smell at about 1 ppm, 100 times below the limit where it will start to become a health hazard. Acetone is another chemical with good warning properties. The OSHA PEL is 1,000 ppm and the ACGIH TLV is 750 ppm. The odor threshold varies from 3.5 to 650 ppm. In any case, with xylene and acetone, employees, not in an industrial setting, will start complaining far before a hazardous exposure limit exists.

9.1.5.1.2. Olfactory Fatigue: Some chemicals make the nose tired of smelling them. This was an advantage when man was running around in an animal skin living in a cave. I would imagine between body odor and no sanitary conditions there would be a considerable (to use modern terms) indoor air quality problem (stink). So we developed the ability to not smell something after awhile. Some chemicals act on this ability too well. Hydrogen Sulfide gas, a poisonous gas, smells like rotten eggs, however, you will only smell it for 4 or 5 minutes because it causes olfactory fatigue very rapidly. Hence the dangers with the chemical as people assume that it has dissipated, when reality it is still there, they just don't smell it anymore. The olfactory fatigue of hydrogen sulfide gas is not dependent on concentration. Olfactory fatigue can be a factor in indoor air quality. The hydrogen sulfide PEL is 19 ppm, odor threshold varies considerably from 0.001 to 0.1ppm.

9.1.5.1.3. No Warning Odor, or Too Low a Warning Odor: The most dangerous chemical that has no odor and kills people in homes and businesses alike is carbon monoxide. There are no warning properties. Carbon monoxide will cause severe indoor air quality problems at very low levels. Toxicity from overexposure will last many days and can accumulate if the exposure occurs daily. The PEL is 50ppm, however, far below that level people will begin to complain about headaches nausea, lack of concentration and being tired.

9.1.5.1.4. Mercuric Cyanide, 4,4-Methylenedialiline (MDA) and ethion which are heavy duty industrial chemicals, have no odor. Another chemical, n-hexane has an odor threshold that varies from 60 to 245 ppm. The OSHA PEL is 500ppm, however, due to new hazards found with the chemical which include damage to the nervous system (peripheral neuropathy) the ACGIH TLV and NIOSH REL have been lowered to 50ppm, below the odor threshold. N-hexane was used extensively in

the synthetic fingernail industry until recently and many of the workers were developing peripheral nervous system problems. Hydrazine (used in rocket fuel) has an odor threshold of 3.5 ppm and higher. The OSHA PEL is 1 ppm, the ACGIH TLV is 0.01ppm and the NIOSH REL is 0.03ppm. All of which are below the odor threshold of hydrazine.

9.1.6. Lack of Exposure Limits. In many cases there are no exposure limits or in some cases even guidelines for the agent causing the indoor air quality problem. There are no exposure limits for molds or the exotoxins. There are no exposure limits for a fellow employee not bathing often enough or wearing too much perfume. There are no requirements (laws like a PEL) for how much fresh air there should be brought into work areas (labs and hospitals excepted). Even the carbon dioxide level is only advised at 1000ppm. Note: the Arizona School Board recently passed a ruling that stated that the carbon dioxide level should be no higher than 1200ppm in schools.

9.2. THE BOTTOM LINE:

Know the chemicals you work with. Read the MSDS and check with your Industrial Hygienist or Safety Professional to insure you understand the hazards and precautions that must be taken. Ensure that even small amounts of chemicals used in an office setting are utilized in areas with adequate ventilation, to including adequate outside air.

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